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ABSTRACT

The Walberg Educational Productivity Model theorizes that learning in its affective, behavioral, and cognitive aspects is causally influenced by factors in the areas of individual aptitude (i.e., prior achievement, age or stage of maturation, and motivation), instructional treatment (i.e., quantity of time spent in learning situations and perceived quality of the learning experiences), and environment (i.e., home, classroom, peers, and out-of-school time). To determine whether the model is appropriate for research in the community college setting, it was tested at the College of Lake County (Illinois), using student grade point average (GPA) as an indicator of student productivity. The study sample was composed of 540 students, who were older than the traditional (18- to 21-year-old student and uninvolved in the life of the college. A 48-item questionnaire was administered in class to obtain background information as well as information on the nine factors included in the productivity model. Study findings, based on 472 usable responses, included the following: (1) on the average, women had higher GPA's than men, part-time students had higher GPA's than full-time students, and night students had higher GPA's than day students; (2) the Walberg model explained 34% of the variability in student GPA; and (3) some variables seemed to have a negative effect on GPA, including quantity of instruction. (EJV)

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Factors Influencing Learning at a Community College

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Paper presented at the annual meeting of the
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INTRODUCTION

Determining how learning occurs at a community college is a difficult task. The students who attend such institutions come from more diverse backgrounds and have greater variation in levels of academic ability than four-year college students. Additionally, community colleges are noted for their high attrition rates. What factors affect learning at the community college? Are any of these factors manipulable in search of greater learning by the student? Questions such as these need to be researched. In order that this task can be approached systematically, guidance is needed from the body of theory which informs the study of student productivity at all levels of education in this country.

AN EDUCATIONAL PRODUCTIVITY MODEL

In recent years, education at all levels has become one of the largest and most expensive enterprises in America. During the last few decades, total spending on schools and colleges has risen from $10 billion to $200 billion per year (Walberg, 1984b, p. 19). Concomitant with these increases in spending has been the realization that student achievement has been decreasing in U.S. schools. The well-documented downward trend in ACT and SAT scores since the early sixties is often cited as an example of the fact that public primary and secondary education in the U.S. is not accomplishing its mission (Bowen, 1982, p. 114). In various international studies, the U.S. has fared poorly, with its students falling further behind their international counterparts at each ascending grade level (Walberg, 1984b, p. 19).

In the context of these facts, the rhetorical question of

whether or not the U.S. education system is accomplishing its task is being asked with a greater sense of urgency than ever before. In 1983, a well-circulated report, A Nation at Risk, stamped a judgment of unsatisfactory on primary and secondary education and called for changes in the system. More recently higher education has had its turn in the evaluation pillory with several commissions calling for everything from curricular to financial reform. In essence, the public at large is viewing the accumulated evidence and asking the education enterprise to become more productive - to do more with its current level of resources.

If U.S. education is to be more productive, appropriate measures for productivity must be found and the factors which influence productivity must be determined. It must also be ascertained whether or not these factors can be manipulated in search of increased productivity.

In an effort to better understand the idea of productivity in an educational context, some help can be found by examining what has proven profitable in the other human sciences. For instance, in psychology there is the notion of a psychological production function. An example of this is the explanation of behavior given in the literature by Lewin (1963). This idea is expressible in equation form as:

$$B=f(P,E)$$

i.e., behavior (B) is a function of personality (P) and environment (E). This equation is an attempt to subsume a large number of psychological theories under one general rubric.

A similar statement can be made in the field of education and expressed as the equation: 4

$$L=f(A,T,E)$$

i.e., learning is a function of individual aptitude (A), instructional treatment (T), and environment (E) (Walberg, 1981). This equation summarizes in a succinct, albeit general, form many of the results of educational research.

More recently, the conceptual framework of this equation has been summarized in a very specific model (Walberg, 1981; Walberg, Pascarella, Haertel, Junker & Boulanger, 1982; Walberg, 1984b) depicted in Figure 1. The model theorizes that learning in its affective, behavioral and cognitive aspects is causally influenced by nine factors in three areas. The factors can interact with each other as indicated by the arrows between the factors in Figure 1. To some extent the factors can substitute for each other. Some of the factors, especially time, exhibit diminishing returns, i.e. initial increments of the factor produce more change than later increments. It is important to note that no one factor is important to the exclusion of the others. The factors must be regarded as an interactive system in their influence upon learning. The three areas and their constituent factors are summarized in Table 1.

The model has been developed from research syntheses of numerous educational studies. It has been subjected to several large scale tests; the first using science achievement scores of 3,049 17-year-old students from National Assessment of Educational Progress (NAEP) data (Walberg, Pascarella, Haertel, Junker & Boulanger, 1982), and the second using the general achievement and attitude scores of 1,955 17-year-old students from NAEP data (Walberg, Fraser & Welch, 1986). In each case the model was found to be operative. Thus, the model has been the

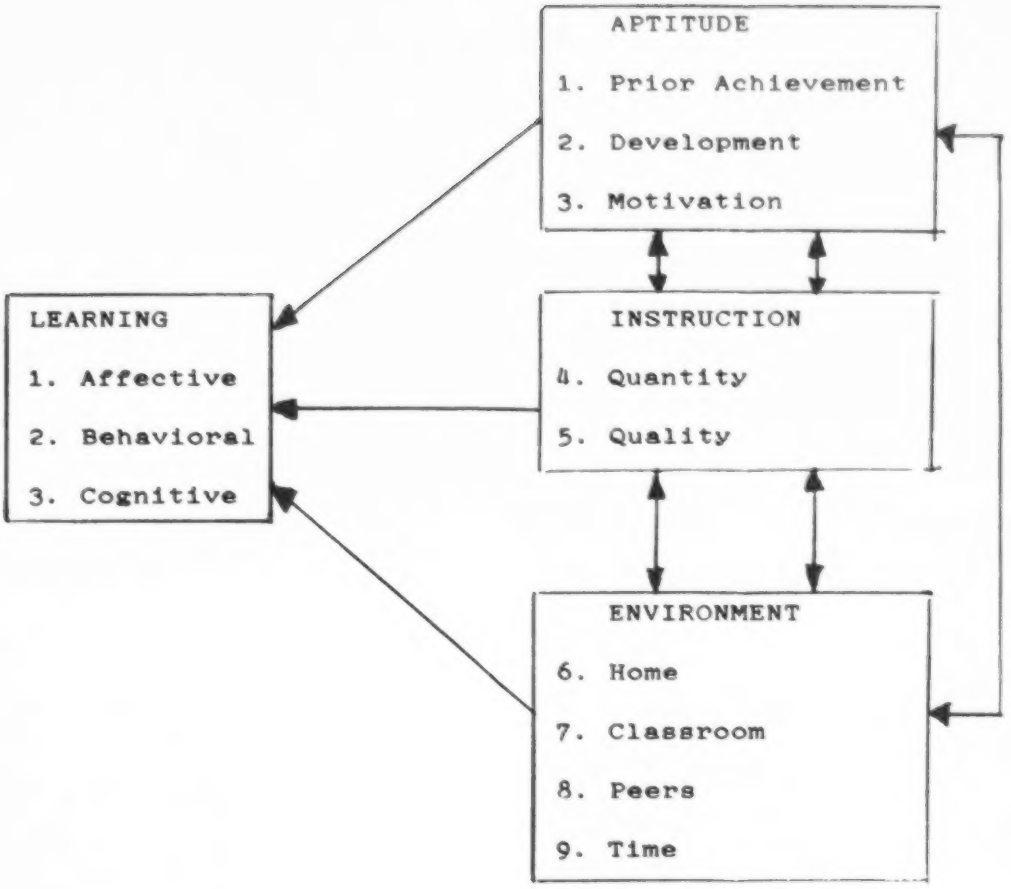

Figure 1 - Walberg Productivity Model (Walberg, 1984b)

Table 1 - Definition of Productivity Factors (Walberg, 1984b)

APTITUDE

1. Prior Achievement - past performance in educational activities.
2. Development - age or stage of maturation.
3. Motivation - willingness to persevere on learning tasks.

INSTRUCTION

4. Quantity - amount of time spent in learning situations.
5. Quality - the student's perception of the value of the learning experience. The amount of instructional resources utilized and the effort put forth by instructional personnel in implementing the learning experience.

ENVIRONMENT

6. Home - the support of the home for learning experiences.
7. Classroom - the social context of the classroom.
8. Peers - the support of the peer group for learning.
9. Time - use of out-of-school time.

object of considerable scrutiny in the primary and secondary environment and has emerged as a powerful explanatory tool in those sectors.

Credence has been given to the viability of the model in a postsecondary setting by its use at Brigham Young University in Utah (Salisbury, 1982). There it was found that all factors except home environment and quality of instruction were operative.

Thus, there seems a reasonable basis for regarding the model as an appropriate description of the factors influencing learning at all educational levels. This makes it a logical choice as a theoretical underpinning for research at the community college.

ANALYSIS OF THE SAMPLE

The question remains of whether or not the productivity model, or some form of it, is appropriate in the community college setting. There is a reasonable basis for its use, but the question is: does it work? To determine this, the model has been tested at the College of Lake County in Grayslake, Illinois. This is a public two-year institution with enrollment of approximately 12,000 (4400 full-time equivalent). In this test, Grade Point Average (GPA) was used as an indicator of students' educational productivity.

The test was conducted on a sample of 472 students in the fall semester of 1985. Class sections were used as the primary sampling unit because this was the most practical way of obtaining a random sample of students in credit classes. Non-credit and continuing education students were not sampled because the dependent measure of GPA was not available for these groups. The method employed for sampling skewed the sample in

the direction of full-time students, since a student enrolled in four classes had four times the chance of being in a sampled class section as a student enrolled in just one class. Since full-time students are an important minority (17%) in the college's total enrollment, there are many important questions about this group. Oversampling ensured that there was a sufficient number of full-time students included and improved the explanatory power of the sample concerning questions about them.

In addition, the sample was variegated (Walberg, 1984a, p. 384). Such a sample contains more observations from the extreme ends of the possible values of the independent variables. This gives the sample improved explanatory power because a wider range of independent variable values and their effects on the dependent variable are incorporated in the data analysis. Stratified random sampling is an excellent way to oversample extremes of variation (Walberg, 1984a, p. 384). Hence, the sample was collected in a way that ensured that classes from each of the college's instructional divisions were included in the sample in the same proportion as that instructional area's share of the total enrollment. In this way, the maximum number of groups was represented, thus including the largest number of possible sources of variation.

The sample was composed of 31 course sections containing a total of 540 students. The data were gathered in a questionnaire which the instructors administered to their students. The questionnaire contained 48 questions designed to determine the nine factors in the productivity model, as well as a number of questions to obtain background information. Of the total of 540 questionnaires, 68 could not be used because of missing or

unintelligible responses. This left 472 questionnaires which were usable.

The sample size was considered adequate for the use of multivariate techniques since it was about ten times the number of items in the questionnaire. The number of observations should be ten to twenty times the number of predictor variables (Ahlgren & Walberg, 1975, p. 47). Since the predictor variables will certainly be a subset of the items on the questionnaire, there will be less than 48 predictor variables, so a sample of 500 will easily meet the prescribed constraint.

Table 2 indicates the composition of the sample by certain categories as contrasted with the composition of these categories in the college's population. The percentages of each subgroup in the sample mirror fairly closely the percentages of that subgroup in the population. The exceptions are full-time students which were deliberately oversampled and male students which were unintentionally oversampled. The slight overrepresentation of male students occurred because of the proportional sampling of each instructional division. The divisions which feature many technological programs are predominantly male in enrollment. Comparison of the two parts of Table 2 indicates that even with the two aberrations mentioned, the sample appears to be representative of the population.

Table 3 lists the means, standard deviations and medians of some important variables collected in the sample. This Table provides a profile of the average student at the college. The data reveal that this student is older (almost 27 years of age) than the traditional college student and is employed approximately 30 hours a week. The student spends slightly more

Table 2 - Composition of the Sample
And Population
By Percentages of Students in a Category

	SAMPLE	COLLEGE POPULATION
Time of Attendance		
Day	53.6%	50%
Night	46.4%	50%
Enrollment Status		
Full-time	37.1%	17%
Part-time	62.9%	83%
Gender		
Female	44.7%	55%
Male	55.3%	45%
Marital Status		
Married	33.8%	Not Available
Not Married	66.2%	Not Available
Employment Status		
Unemployed	16.7%	Not Available
Part-time	31.6%	Not Available
Full-time	51.7%	Not Available

Note: Under Enrollment Status, Full-time means a student is enrolled for 12 or more credit hours while Part-time means a student is enrolled for less than 12 credit hours.

Table 3 - Means, Standard Deviations and Medians
of
Important Student Characteristics

VARIABLE	MEAN	STANDARD DEVIATION	MEDIAN	COMMENTS
GPA	2.78	.79	2.83	
Total Credits	28.51	21.41	23	
Hours Withdrawn	2.66	4.68	0	
Age	26.87	9.69	23	
Credits This Term	8.86	4.70	8	
Hours per Week Employed	30.32	17.87	38	
Out-of-Class Contacts with Instructors Per Semester	2.86	5.19	1	(39% report 0)
Television Hours per week	9.62	7.97	8	
Homework	10.77	9.19	9	
Reading for Pleasure in Hours per Week	4.82	5.47	3	
College Events Attended Per Semester	.72	2.28	0	(76% report 0)

time doing homework than watching television, but spends roughly twice as much time watching television as reading for pleasure.

The average student is also not very involved in the life of the college. This is evidenced by the fact that there is little out-of-class contact with instructors (39% report no contacts in a semester) and virtually no attendance at college events (76% report attending no events in a semester). The mean of 2.86 out-of-class contacts per semester coupled with a median of one contact indicates that the distribution of contacts is positively skewed. The higher value of the mean than the median occurs because a small number of students is making most of the contacts.

The average student has almost one year of college (28.51 credit hours) by full-time standards, is currently enrolled for almost nine hours and has withdrawn from 2.66 credit hours (approximately one course). One notes also that for virtually every variable, the mean is larger than the median (GPA and hours of employment are the only exceptions), so the bulk of the data is positively skewed as was discussed above for out-of-class contacts.

Table 4 reveals a number of interesting differences among the subgroups. In the area of GPA: women do better than men, part-time students perform better than full-time students and night students outperform their day counterparts. Men watch more television per week than women. Part-time students spend almost twice as much time per credit hour on homework as do full-time students and a similar ratio holds between the homework per credit hour of night students versus day students. Men, full-time and day students make significantly more out-of-class

contacts with instructors than women, part-time and night students. Finally, the ages of night and part-time students are greater than the ages of day and full-time students.

The data seem to be mutually reinforcing. For instance, that part-time students do better than full-time students can be partially explained by the fact that the part-time student spends more time per credit hour in study. What is of interest is whether the differences observed can be explained by the factors in the productivity model, rather than by gender, enrollment status, or enrollment time.

A finding of major interest in the sample analysis is that GPA does not vary significantly across area of study or major at the College of Lake County. An analysis of variance of GPA on twelve areas of study (see Table 5) indicated no difference in GPA across the areas at a .05 level of significance. This is in contrast to the situation at four-year institutions where GPA varies significantly across majors (Astin, 1977, p. 226).

There are several explanations for the lack of influence of area of study on GPA. First, the notion of major is not well-defined at the community college. For transfer students, there are only two options for a major: Associate of Arts or Associate of Science. These two categories subsume many possible areas of interest. Thus, these two areas are an amalgamation of different preferences of study and conceal the differences among these areas. For the career student, many of the courses taken are either introductory, or in prerequisite areas such as mathematics and English common to several curricula. Since many of the students who come to the community college are underprepared academically, their performance is similar in such

Table 4 - Variables with Significant Differences Between Dichotomous Subgroups of the Sample

	GENDER		ENROLLMENT STATUS		ENROLLMENT TIME	
	Men	Women	Full-time	Part-time	Day	Night
GPA	2.71 < 2.85 alpha=.05		2.52 < 2.92 alpha=.05		2.54 < 2.98 alpha=.01	
TV	10.36 > 8.69 alpha=.05					
Homework			.99 < 1.77 alpha=.01		1.04 < 1.87 alpha=.01	
Cont	3.29 > 2.33 alpha=.05		4.48 > 1.91 alpha=.01		3.27 > 2.51 alpha=.1	
Age			21.37 < 30.12 alpha=.01		22.51 < 30.65 alpha=.01	

TV = Hours of television viewed per week.

Homework = Hours of homework done per credit hour per week.

Cont = Number of out-of-class contacts with faculty per term.

alpha = level of significance of the t-test.

Table 5 - Areas of Study Used for ANOVA

AREA OF STUDY	DESCRIPTION
University Transfer	
Associate of Arts	General Arts and Sciences
Associate of Science	Engineering, Mathematics and Physical Science
Career Areas	
Medical Technologies	Nursing, Radiography Dental and Medical Laboratory
Data Processing	Computer Programming and Operations
Secretarial Science	Office Skills
Business Management	Management and Supervisory Skills
Communications	Technical Writing
Industrial Technology	Architectural, Civil and Electronics Technology. Mechanical Design Technology
Human Services	Law Enforcement and Teaching Paraprofessional
General Studies	Personal Development
Vocational Skills	Retraining for Displaced Workers
Adult Basic Education	Preparatory Program for High School Dropout

courses regardless of what their area of interest may be. Thus, at the community college the idea of a major area of study is quite dilluted and may be hard to detect.

Second, the choice of a major is not a matter of great gravity for the community college student. Many are not sure what they desire to do in the first place (Cohen & Brawer, 1982, p. 56). For such a student, the choice of a major is often prompted only by the need to fill in a curricular choice on an application form. In this context of uncertainty, there is little meaning or commitment to the choice that is made.

Last, recent research shows that major area of study affects achievement most in a supportive environment. For example, an art major will evidence higher achievement in an art-supportive environment than an art major in an environment not supportive of art (Pascarella, 1985, p. 36). At a community college, students, regardless of subject area, are placed in an extremely ambiguous environment academically. They have peers who are not academically oriented and who are indifferent to the idea of academic excellence (Dougherty, 1986, p. 36). Hence, the supportive subcultures which foster excellence in a given major are for the most part not present at the community college. The three factors mentioned all interact to reduce the concept of major as a means of distinguishing among students at a community college.

In summary, the analysis of the sample reveals that:

1. the sample is representative of the student population at the College of Lake County.
2. the sample is of an appropriate size for drawing meaningful conclusions using multivariate statistical techniques.

3. the average student at the college is older than the traditional 18-21 year-old student and uninvolved in the life of the college.

4. on the average women have higher grade point averages than men, part-time students have higher grade point averages than full-time students and night students have higher grade point averages than day students.

5. GPA does not vary across area of study at the College of Lake County. This is in contrast to the situation at four-year schools where significant differences are found among the grade point averages of students in different majors.

ANALYSIS OF THE VARIABLES USED

The questionnaire which was administered to the sample consisted of 48 questions. The questionnaire was designed to be brief so that it could be administered as part of a class session without consuming more than 15 minutes of class time. The questions were designed to measure the nine factors posited by the productivity model as well as to determine various background characteristics of the students surveyed. Five items of information from the college's data base: GPA, total credit hours earned, credit hours enrolled this semester, hours withdrawn, and curriculum code were also utilized. The initial choice of variables used to measure factors was made when the questionnaire was constructed. The questionnaire was field tested in the summer of 1985 on a sample of 67 students which led to modifications in some of the questions.

Once the questionnaire had been administered, the items which were hypothesized to load on a given factor were summed and the result was taken as a measure of the factor. If the variables

Table 6 - List of Factors and the Constituent Variables

FACTOR	VARIABLES USED TO MEASURE	RELIABILITY
Prior Achievement	Self reported rating of high school achievement	N/A
Development	Age of the student	N/A
Motivation	Two Likert scale items	alpha=.21
Quantity of Instruction	Number of credit hours enrolled in the semester	N/A
Quality of Instruction	Number of out-of-class contacts with instructors + number of events attended + 3 Likert scale items about relationships with faculty (these variables were standardized to a mean of 0 and standard deviation of 1)	alpha=.40
Classroom	Three Likert scale items about frequency of evaluation and perception of the intellectual atmosphere of the college	alpha=.21
Peers	Four Likert scale items about the student's view of peers and how they are influenced by them	alpha=.25
Home	One Likert scale item about the view of education in the parent's home	N/A
Time	Logarithm of hours studied per week + hours reading for pleasure per week divided by credit hours enrolled in the semester	N/A

Note: The alpha indicated under the reliability column is the Cronbach alpha.

measuring a given factor utilized different metrics, the variables were standardized to a mean of zero and a standard deviation of one. This was done in order that the proper contribution of each variable to the variance of the factor could be determined. The variables used to define the factors are described in Table 6.

To empirically verify the choice of the variables, a principal components analysis was performed on the data. Using a criterion of a minimum eigenvalue of one, the analysis indicated seventeen factors. The large number of factors occurred because the analysis included questions about background information. A principal components analysis on only the 23 Likert scale items resulted in eight factors.

The loadings of the variables on the factors were examined in order to name the factors extracted. Unfortunately, the loadings were not large and there was substantial difficulty in deciphering the meaning of the factors. Kaiser's measure of sampling adequacy (MSA) was computed. This is a measure for each variable individually and all variables collectively of how much smaller the partial correlations are than the simple correlations (SAS Institute, 1982, p. 332). If the partial correlations are small relative to the simple correlations, this means that the factors will be easily discernible. If the partial correlations are as large or larger than the simple correlations, then it will be difficult to identify the factors. The overall MSA for the sample was .77. The MSA for good factor analytic data should be at least in the .80's and is not considered excellent until the .90's are reached (Kaiser, 1970, p. 405). The values of the MSA's of the individual variables ranged from .40 to .90, with a

number of the variables having scores of .50 to .60, which are considered poor. Thus, the data collected were not of a high quality from a factor analytic point of view.

The recommended procedure in this situation is to delete the offending variables (SAS Institute, 1982, p. 327). As a result the number of variables used to measure certain factors was reduced. In several cases, it was found that the simplest measure for a factor was best. For example, the factor of development was originally measured by age of the student plus whether or not the student was a military veteran, plus two Likert scale measures of the student's conception of personal success. Upon analysis it was found that the latter variables were all highly correlated with age and did not add significantly to the factor of development. Age alone was the most efficient measure.

When the questionnaire was devised, the factor "home" was measured in terms of marital status and number of children. This was done to allow the factor to measure structural characteristics of the home rather than more subjective attributes such as the student's perception of the home atmosphere. The factor analysis revealed that these variables loaded on age because marriage and having children are associated with being older. As a result, these variables were deleted from the factor home leaving only one Likert scale item which asks whether education was highly valued in the home of the student's parents. Any significance this factor may have is certainly dubious because of the imprecise nature of its measure.

The variable time was measured by the sum of hours of homework per week and hours of reading for pleasure per week

divided by the number of credit hours for which the student was enrolled in the semester. The theory surrounding the productivity model indicates that time spent in study produces diminishing returns, that is, the initial hours of study contribute more to learning than the latter hours. Since the contribution to learning of a variable exhibiting diminishing returns is certainly curvilinear, the natural logarithm of the quantity was taken before using the variable in a regression equation.

The principal components analysis was not extremely helpful in identifying factors. Thus, it was necessary to rely upon the original conception of what each item on the questionnaire measured to assign variables to factors. Some guidance about the type of item to use was obtained from the productivity model. For instance, the measures used for time were a variant of those used to measure time in other tests of the model. Thus, while the factor analysis was somewhat helpful in refining the measures used, the guidance of the productivity model was ultimately more helpful.

From Table 6, it is seen that the Cronbach alpha reliability of the measures comprising several of the factors is quite low. It was suspected that this was not because the measures were inappropriate, but rather that these measures probed several dimensions of the factor. To test this idea, four separate principal components analyses were done on the variables composing peers, classroom, motivation and quality of instruction. In each case, the analysis gave nearly as many components for the factor as there were variables. Yet, examination of the variables which were used to measure the

factor did not indicate that it was unsound to regard them as measures of the factor. Thus, the only conclusion was that the measures probed different dimensions of the factor. For instance, there are two questions assessing motivation. It appears that one measures personal motivation to complete a task, while the second measures a person's view of the role of motivation in success. These variables clearly measure two different things, yet both measure facets of motivation.

The same can be said of the items measuring peers. One measures the influence of classmates, while the others concentrate on the influence of friends. Again both items measure different, but necessary, components of the factor peers.

The questions used to measure classroom exhibit similar tendencies. One group of questions loads on being provided with regular information about academic progress, while the other group loads on the learning atmosphere at the college. Again both components are necessary parts of measuring the influence of classroom.

The crux of this discussion is that it was decided that the items selected were appropriate measures for the factors indicated even though the reliability measures were low. The reason is that it appears to be defensible to regard the items as different dimensions of the same factor. The items are different enough so that they are not highly correlated, yet they are different facets of the same general entity.

In summary, analyses of the variables revealed that:
1. the quality of the data for factor analytic purposes was marginal and therefore, investigator judgment and productivity model theory were better guides for determining which variables

should measure a factor than the statistical technique.

2. the simplest and best measure for development is age since most other measures of development are highly correlated with it and thus give little new information.

3. the variables used to measure the factors probed different dimensions of each factor, thus leading to low reliability scores.

ANALYSIS AND DESCRIPTION OF THE TEST

Once appropriate variables were determined, testing of several alternative forms of the model was possible. The principal tool used in this analysis was PROC STEPWISE in the Statistical Analysis System (SAS). This procedure places variables into a model in order of their contribution to the variance of the dependent variable. Factors which do not meet a specified level of significance are not included at all.

The theoretical framework in which a model is devised is the principal guide for interpreting the results of an educational study. For example, on the basis of the productivity model, one expects diminishing returns from the factor time. Hence, results which either corroborate or deny diminishing returns in time need to be identified. The possibility of diminishing returns for other factors ought to be examined also.

The possibility of interactions among the factors is a phenomenon which needs to be probed. When looking for interactions, care needs to be exercised to ensure that the interactions are not spurious. This can occur in any situation where there are a large number of independent variables. For instance, in an equation with nine independent variables, there are 72 (9 X 8) possible pairwise interactions. If a significance

level of .05 were used, it is possible to get approximately four (.05 X 72 = 3.6) interactions which are purely of a chance nature. There are two ways to guard against attributing significance to a spurious interaction. First, there is the principle of parsimony. If the number of factors in the model is kept as small as possible, this mathematically reduces the chance for spurious interactions. A model with four factors has only 12 (4 X 3) pairwise interactions.

Second, there is the principle of explanation. Any interactions must be evaluated in the theoretical context of the model. For example, in the productivity model being tested, consider the occurrence of a significant interaction between age and quantity of instruction. This interaction could be safely labeled as spurious because there appears to be little theoretical support for such an interaction in the model. The principle of explanation demands that in addition to being statistically significant, an interaction must be theoretically significant. That is, the interaction must make sense in the theoretical framework of the model.

While the importance of having a solid theory to guide inquiry cannot be overemphasized, it is also important that the astute researcher be prepared for the unexpected. When testing a theoretical model, one has to examine where the model has potential weaknesses and where the deletion of existing variables or the inclusion of new variables is appropriate. For instance, in the productivity model there is no mention of variables such as race, gender or socio-economic status. In any test, the possibility of significant influence by background variables such as these must be considered.

Table 7 - Linear Form of the Productivity Model

Dependent Variable - GPA

Variance Explained - 34.1%

PARAMETER	ESTIMATE	T-SCORE	PROB> T
INTERCEPT	.8413	2.37	.0181
PRIOR ACHIEVEMENT	.3381	8.45	.0001
DEVELOPMENT	.0219	5.52	.0001
MOTIVATION	.0693	2.90	.0039
QUANTITY OF INSTRUCTION	-.0160	-1.94	.0524
QUALITY OF INSTRUCTION	.0314	2.75	.0061
CLASSROOM	.0299	1.77	.0769
PEERS	-.0086	-0.55	.5794
HOME	-.0624	-2.06	.0398
TIME	.1029	2.26	.0244

Table 7 delineates the results of a linear model utilizing the factors as described in Table 6. Table 7 indicates that the model is quite robust in accounting for the variance in the dependent variable of GPA.

If the level of significance is taken as .05, classroom and peers are not significant and quantity of instruction barely misses significance. If the significance level is raised to .1, all factors except peers are significant. In either case note that only peers is not close to significance. This is probably because the items that measured peers in the questionnaire did not probe the factor very well. Nonetheless, the model explains about 34% of the variance in GPA, a healthy figure.

Some further discussion of Table 7 is necessary. Several of the variables affect GPA negatively. No attention need be paid to peers, because its influence is not significant. The negative influence of the factor home is surprising, but cannot be given too much credence because home is measured only by one Likert scale variable. Therefore, its reliability is open to question.

The fact that quantity of instruction affects GPA negatively is somewhat troubling although there are two explanations for it. First, at the college most of the students are employed (see Table 2 and Table 3). School is something that they have fit into an already full schedule. Enrollment for several courses constitutes a demand on their total available time which may not be realistic. Thus, when students do so, they perform poorly which negatively influences GPA.

Second, earlier in this chapter it was noted that evening students performed better than day students and part-time students performed better than full-time students (see Table 4).

Since most of the full-time students are enrolled in the day, this means that the group of students who fare the worst in the comparisons in Table 4, are the ones enrolled for the most hours. Clearly, this negatively affects GPA in the sample.

The parsimony of the results in Table 7 was checked by doing a stepwise regression of those variables plus some additional variables delineated in Table 8. The results of this regression indicated that only the degree sought by the student added significantly to the variance of GPA. Sex, enrollment status and time of attendance were not significant.

The model augmented with the variable of degree corresponded to the results in Table 7 in all respects. All variables that were significant before remained significant. The variance in GPA explained by adding degree rose by 1.3% to 35.4%. Originally, the variable degree had been in the model as a part of motivation. It was removed from this measure because it was felt that it measured something other than motivation. For instance, it seems logical that a person could desire a given degree and yet not be motivated sufficiently to attain it. Also, it does not seem reasonable to believe that a person who aspires to an associate degree is any less motivated towards that goal than a person who aspires to the PhD degree. The fact that the PhD is a more difficult degree to attain says nothing about the motivation necessary to attain a lesser degree. The significance of degree aspiration is probably best and most correctly

Table 8 - Additional Variables Regressed on GPA

VARIABLE	DESCRIPTION
Degree	Highest degree sought by the individual. 0=other, 1=certificate, 2=Associate, 3=Bachelors, 4=Masters 5=PhD, 6=MD, JD or other professional degree.
Sex	Gender of the Student
Enrollment Status	0=Part-time, 1=Full-time
Time of Attendance	0=Night, 1=Day

interpreted by regarding it as a background variable whose value lies simply in the classification of students.

Next, some evidence of interaction was sought. To facilitate this investigation it was deemed appropriate to bifurcate the productivity factors into two categories: fixed and alterable. Fixed variables are those over which the college has no control. They are intrinsic characteristics of the students in the study. Alterable variables are those which can be at least partially manipulated by the college in search of increased learning. The alterable variables are motivation, quality of instruction, classroom and time. It is most important to look for interactions of the alterable variables with all other variables, because the alterable variables are most useful in a policymaking context. The results of the search for interactions are delineated in Table 9.

Some interesting observations can be made from the results in Tables 8 and 9. First, the variables of sex, enrollment status and time of attendance do not influence GPA significantly. This is somewhat surprising since the analysis of the sample earlier in this paper indicated significant differences in GPA between men and women students, full-time and part-time students and day and night students. The only possible conclusion is that these differences in GPA are explainable by the factors in the model rather than by membership in the dichotomous categories. This fact lends great credence to the model.

Motivation and time is the only significant interaction. Special caution must be used in examining this finding because it

Table 9 - Test for Interactions

Dependent Variable - GPA

Variance Explained - 36.1%

PARAMETER	ESTIMATE	T-VALUE	PROB > T
INTERCEPT	.5379	1.79	.0745
PRIOR ACHIEVEMENT	.3226	8.13	.0001
DEVELOPMENT	.0252	6.52	.0001
MOTIVATION	.0420	1.71	.0875
QUANTITY OF INSTRUCTION	-.0238	-3.01	.0027
QUALITY OF INSTRUCTION	.0104	2.15	.0317
CLASSROOM	.0412	2.59	.0099
PEERS	Not Significant		
HOME	-.0631	-2.12	.0342
TIME	-.7326	-2.71	.0071
DEGREE	.0743	2.85	.0046
MOTIVATION*TIME	.0945	3.00	.0028

could certainly be a spurious interaction. One reason that it is not spurious is that it is theoretically plausible. High levels of motivation and time should positively influence GPA. What is troubling is that the contribution of time alone is negative when the interaction is included in the model. A possible explanation surfaces when the profile data in Table 3 are recalled. The average community college student works approximately thirty hours per week, watches television approximately 9 1/2 hours per week and studies nearly eleven hours per week. In such a schedule there is little time to add any additional activity. If motivation causes study time to increase, there will be a positive effect on GPA because of the interaction of motivation and time. However, since study time comes at the expense of other activities, such as rest and recreation, the overall effect of the increased time may well be negative.

It had been originally hypothesized that motivation would interact with other factors as well. For instance, interactions between motivation and prior achievement and between motivation and quality were conjectured and certainly seem reasonable in the light of other research (Pascarella, 1985). It is somewhat distressing that neither of these interactions could be documented. Yet, the interaction between time and motivation is of exceptional importance from a policy point-of-view because both of the variables are alterable.

Finally, the effect of utilizing quadratic (square) terms is explored. Table 10 indicates which variables are significant if a square term is added for each factor.

Table 10 - Model with Quadratic Terms Included

Dependent Variable - GPA

Variance Explained - 40.6%

PARAMETER	ESTIMATE	T-VALUE	PROB > T
INTERCEPT	-.8239	-2.39	.0174
DEVELOPMENT	.1564	8.22	.0001
MOTIVATION	.0398	1.76	.0795
QUALITY OF INSTRUCTION	.0259	2.53	.0116
TIME	.1123	2.45	.0145
DEVELOPMENT*DEVELOPMENT	-.0019	-6.82	.0001
TIME*TIME	-.0588	-2.29	.0255
DEGREE*DEGREE	.0075	1.82	.0701
PRIOR ACHIEVEMENT*PRIOR ACHIEVEMENT	.0647	9.19	.0001

The square of time contributes negatively to GPA while the influence of the linear term in time is positive. This indicates that when the other factors are controlled, the relationship between GPA and time is quadratic with the curve of the relationship concave down. This is illustrated in Figure 2. This finding suggests not only that time has diminishing returns on GPA, but eventually negative returns. That is, initial increments of time affect achievement more than subsequent increments and eventually a point is reached where the influence becomes negative. Recall that time is measured by the logarithm of hours of homework plus hours of reading for pleasure per credit hour. The logarithm of this quantity was used in an effort to linearize the contribution of time since diminishing returns were expected on the basis of the theory of the productivity model. The fact that diminishing returns still appear even after efforts to correct for them indicates the pronounced nature of this effect in this instance.

A similar situation occurs for development (age). Diminishing returns occur for age since the coefficient of the linear term is positive while the coefficient of the quadratic term is negative. The graph of this is indicated in Figure 3.

The fact that the curves for both time and age are quadratic and concave down when the other variables are controlled suggests the possibility of some optimum time or age at which negative effects on grade point average will begin to appear. This optimum value will be the value of the independent variable at which the largest value of GPA occurs. Thus, it will be the value of the independent variable at the vertex of the quadratic curves depicted in Figures 2 and 3. For instance, consider

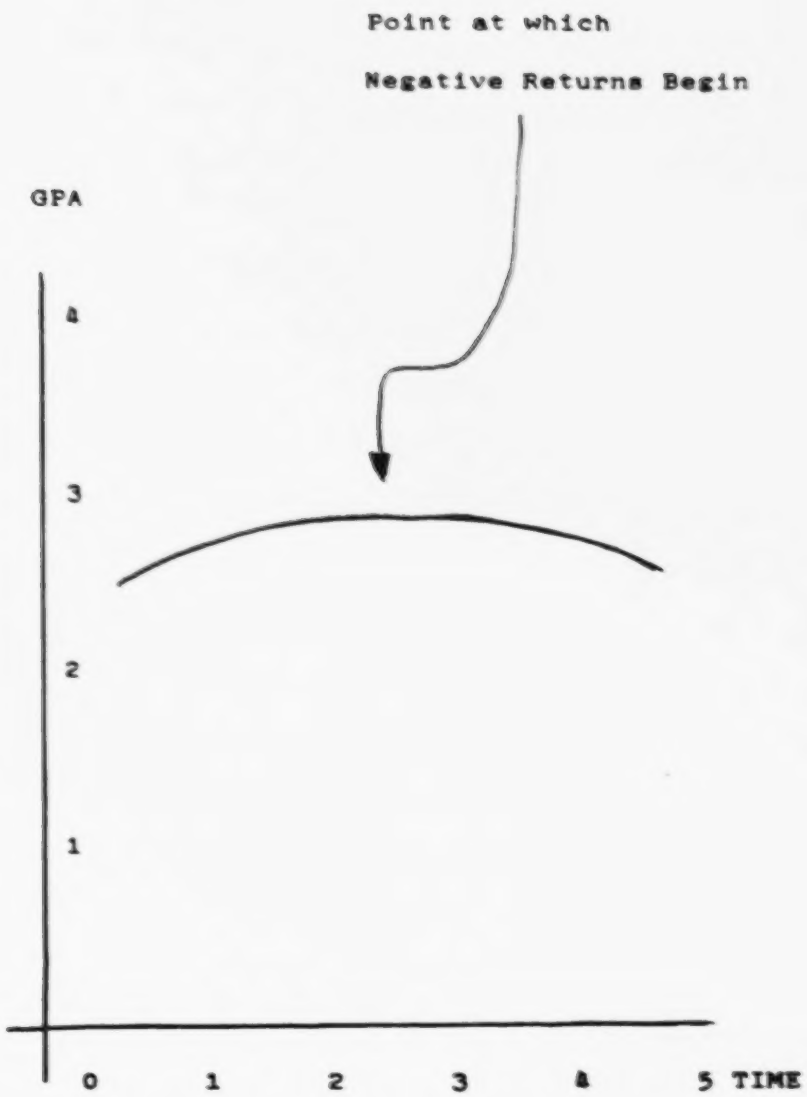

Figure 2 - Relationship of TIME and GPA
(Other independent variables controlled)

Note: The other independent variables are controlled by using their median values.

Figure 3 - Relationship of AGE and GPA (Other independent variables controlled)

Note: The other independent variables are controlled by using their median values.

the following equation for GPA in terms of time excerpted from Table 10.

$$GPA = -.0588\ TIME^2 + .1123\ TIME + Controlled\ Variables$$

Using the techniques of the calculus to optimize functions, the first partial derivative of GPA with respect to time is computed and set equal to zero. This results in:

$$-.1176\ TIME + .1123 = 0$$

and hence, that

$$TIME = .955$$

Recall that this is the logarithm of a quantity, so it must be antilogged to give an answer in the units of the original data. When this is accomplished, a value of 2.6 hours of homework and pleasure reading per credit hour results. This is the value beyond which the contributions of time to GPA are negative. It is at the vertex of the curve in Figure 2.

If the same procedure is followed for GPA as a function of age, the result is:

$$GPA = -.0019\ AGE^2 + .1564\ AGE + Controlled\ Variables$$

The first partial derivative of GPA with respect to AGE is set equal to zero arriving at:

$$-.0038\ AGE + .1564 = 0$$

$$AGE = 41.16\ years$$

This result is the value at which the maximum benefits of age on GPA are achieved. It is the value of the independent variable at the vertex of the curve in Figure 3.

These results must be interpreted with great caution. They do not mean that a person must study and read exactly 2.6 hours per credit hour to achieve maximum GPA. They simply mean that

the effect of time on GPA is positive for 0 to 2.6 hours of homework and pleasure reading per credit hour. If more time than that is spent in these activities, the increased use of time may have a negative effect on GPA. This value for time occurs in the midrange of values for the variable in the data, since the first quartile of time is one hour and the third quartile is 2.92 hours with a median of 1.67 hours.

Similarly, the computations involving age do not dictate that a person must be 41 years-old in order to maximize GPA. It means that increasing age affects GPA positively until age 41, at which time the age no longer has a positive effect on achievement. However, unlike the value for time which is at the midrange of observed values, age has an extremely large value. It is between the third quartile of 31 years and the 95th percentile of 47 years. Most of the college's students are well below the age at which negative returns begin.

It must also be noted that in these results the values of the other independent variables have not been mentioned except to say they are controlled. In Figures 2 and 3, the median values of the controlled variables were used so that the graphs could be sketched. The median values were selected since the variables were skewed and thus the median was a better measure of central tendency than the mean. In an actual situation these variables may assume many values. Thus, persons at or beyond the optimizing figures for age and time can substitute other factors in an effort to positively influence GPA. For instance, it is well-documented that older students exhibit high levels of motivation when performing educational tasks. Since Table 10 indicates that the effect of motivation on GPA is always

positive, this may be an instance of substituting motivation for some other factor.

These are interesting results! The first indicates that when college teachers tell students that in order to be successful, they must study two hours outside of class for every hour in class, there may be an empirical basis for this claim. If the mean number of hours of pleasure reading from Table 8, 4.82 is divided by the mean number of credit hours for which the student is enrolled, 8.86, the result is .54 hours of pleasure reading per week per credit hour. If this figure is subtracted from 2.6, the result is 2.06 hours. This is very close to the prescribed amount of study time.

Further, the fact that there is an age beyond which achievement (as measured by GPA) becomes more difficult and students' efforts produce less return is intuitively plausible. Students in this category will have to substitute other factors for those in which they are past optimum values.

One must be very skeptical of the values of these two numbers. They are averages, and what they mean in the case of a particular individual is problematic. Also, since these figures were obtained in a study of only one institution, their generalizability is doubtful. These findings certainly need further research in more general situations before more definitive statements can be made.

The remainder of the results conform to expectations. The square of degree overwhelms the linear term of degree and positively influences GPA as does the square of prior achievement. Motivation contributes only through a linear term, but its coefficient is positive as expected.

Of the three alternatives for the model: linear (Table 7), linear and interactions (Table 9), and quadratic (Table 10), the quadratic version is clearly the most parsimonious. It explains 40.6% of the variance in GPA using the linear and/or quadratic terms of six factors.

It needs to be emphasized that the three versions of the model given in this paper are not presented as mutually exclusive alternatives. Each version has utility in different situations. The point is that the productivity model in some form is operative at a particular community college. It predicts creditable amounts of the variance in GPA and functions in accord with its theoretical underpinnings.

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